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# Mortality Rate of Mosquito Species to Dichloro-Diphenyl-Trichloro-Ethane (DDT) and Deltametrin Insecticides

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**Abstract** – *Environmental management is very crucial for the development of our society. Poor environmental cleanness often attract vector parasite typically mosquito (causative agent of malaria). According to World Health Organization (WHO), about 438000 people die in 2015 due malarial infection. Vector control using insecticide-treated bed nets and indoor residual spraying (IRS) is an effective way of reducing malaria transmission. However, the major challenge is that those mosquitoes are developing resistance to insecticide. This study was carried out to assess the mortality rate of mosquitoes to dichloro-diphenyl-trichloro-ethane (DDT) and deltamethrin in five communities of Billiri local government area of Gombe State. Adult mosquitoes raised from larvae were collected across the five communities. Insecticide susceptibility tests using WHO papers treated with 4% (DDT) and 0.05% deltamethrin were carried out. Mosquitoes from the five communities were fully 100% susceptible to deltamethrin on the 24 hours post exposure period and no resistance observed. According to WHO recommendations, 98-100% mosquito mortality after 24 hours post exposure period indicates susceptibility, 80-97% suggests potential resistance that needs confirmation, and < 80% mortality suggest resistance. Mosquitoes exposed to DDT after 24 hours in Kekkel community exhibits the highest mortality rate of 62% and Kasuwa with the least mortality rate of 10%. Based on the result of this study, the use of deltamethrin insecticide is still an effective means of preventing malaria transmission in Gombe metropolis. In addition, the research is also important in establishing mosquito treatment baseline depending on chemical preferentiality* 

**Keywords:** Mortality, DDT, Deltamethrin, Billiri

## 1.0 INTRODUCTION

Mosquito is the principal vector of many of the vector borne diseases affecting human beings and other animals. Several mosquito species belonging to genera Anopheles, Aedes and Culex are vectors for the pathogens of various diseases like malaria, filariasis, Japanese encephalitis, dengue fever, West Nile virus, yellow fever and chikungunya [1]. Mosquitoes can transmit more diseases than any other group of arthropods and affects millions of people

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throughout the world. World health organization has declared it as the most "public enemy" number one [2].

They are most important insects that affect human health, especially the poor, who are more at risk of its bite hence falling sick and when they get ill, the use for buying medicine can create a poverty visions circle, consequently, contributing directly to poverty stabilization in Nigeria. The blood sucking insects that are responsible for the transmission of many diseases throughout the human and animal populations of the world, is one of the vector that exert enormous burden on the continent of Africa and Nigeria in particular[3]. Mosquitoes vary from one region to the other, the difference between these species can be quite dramatic, for instance, some species of mosquitoes never bite people, others prefer birds or amphibians hosts [4]. Certain mosquito species prefer to take blood during the day time, while others at night [5].

To prevent proliferation of mosquito borne diseases and to improve quality of environment and public health [17], mosquito control is essential. The major tool in mosquito control operation is the application of synthetic insecticides such as pyrethroids, organochlorines and organophosphate compounds [6]. Insecticide based interventions remain the principal vector control measure in malaria endemic countries.

However, knowledge on vector insecticide resistance status, changing trends of resistance in target vectors and their operational implications remain basic requirements to guide insecticide use in disease control programmed [2]. Development of insecticide resistance malaria vectors has been a major problem for achieving effective vector control. Due to limited availability of insecticides, the only option is management of resistance by judiciously using the insecticides and rotating them to maintain their effectiveness [7].

Vector control is an important element of strategies used to control major vector-borne diseases globally, and chemical control remains the most widely used approach. In recent years, interventions using insecticides have been scaled up in many countries [8]. The need to develop effective systems for pesticide management has been emphasized to ensure judicious use of insecticides, manage insecticide resistance and reduce risks to human health and environment, within the context of an integrated vector management (IVM) approach [8, 9, 18]. The research is very important in defining the rationale behind decision making for optimal use of chemicals in vector control process.

Most mosquitoes specie are becoming resistance to insecticide nowadays, the assessment of other treatment chemical can go a long way in blocking the mosquito's shifting resistance ability. Therefore this research focus on assessing the effect of dichloro-diphenyl-trichloro-ethane (DDT) and deltamethrin insecticide on mosquito's mortality rate with a view to reduce Malaria transmission and their potential resistance ability to insecticide.

## 2.0 MATERIAL AND METHODS

### 2.1 Study Area

Billiri Local Government Area lies within Lat. 9°50'N; 11°09´E and Long. 9.833°N; 11.150°E of green which meridian. It covers an area of 737 km² (285 sq m) with a population

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of 202,144 as at 2006 census. It is 45 km away from the capital. The major occupation of the people of Billiri is farming.

### 2.2 Equipments/Materials

Susceptibility test kit includes exposure tubes, holding tubes, copper and silver rings, insecticide-impregnated papers, oil-impregnated control papers, sucking tubes, thermometer, wooden box with large holes, towels, cotton wool, paper cups with cover nets, rubber bands, markers or wax pencils, mosquito cage, ground biscuit/yeast.

### 2.3 Preliminary Investigation

A preliminary survey was carried out within the study areas to identify the breeding sites of mosquitoes.

### 2.4 Mosquito Larvae Collection

Mosquito larvae were collected from the identified breeding sites in Billiri L.G.A of Gombe State. A ladle was used to collect different larval instars. About 7-10 scoops was collected depending on the abundance of the larvae in the water in order to get enough quantity for rearing. Mosquito larvae were put into a small plastic bowl covered with a net. All collected larvae were brought to the insectary laboratory and fed with grounded biscuits or yeast and reared to adult stage. The adult mosquito were transferred to the cage using sucking tubes and fed with 10%-glucose soaked with cotton wool so that adult mosquitoes will attach itself and suck the glucose in the cotton wool [2].

### 2.5 Insecticide Susceptibility Bioassay

The principle of the WHO bioassay is to expose insects to a given dose of insecticide for a given time to assess susceptibility or resistance [10]. Insecticides susceptibility test kits and impregnated papers were used. The mosquitoes were transferred from the hatchery to the cage with the use of an aspirator/sucking tube. In this study, two insecticides were tested: DDT (4%) and Deltamethrin (0.05%). An aspirator was used to introduce 20-25 fed mosquitoes into five WHO holding tubes (four test tubes) and one control tube that contained untreated papers. They were then blown gently into the exposure tubes containing the insecticide impregnated papers. The number of mosquito mortality was observed at 5, 10, 15, 20,30,40,50, 60 minute (1hour). After one hour exposure, mosquitoes were transferred back into holding tubes and were provided with cotton wools moisten with a 10% glucose solution. In the holding tube, mortalities at 24 hours interval were recorded following the WHO procedure [2]. Rate of mortality was calculated according to the formula adopted from Abbot (Abbott 1925) as:

Exposure mortality:

$$(E)=\left(\frac{number\ of\ dead\ mosquitoes}{total\ number\ of\ mosquitoes\ in\ tube\ with\ insecticides}\right) \times 100 \tag{1}$$

Control mortality:

$$(C)=\left(\frac{number\ of\ dead\ mosquitoes}{total\ number\ of\ mosquitoes\ in\ control\ tube}\right) \times 100 \tag{2}$$

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The hypothesis of the method is that, if the control mortality is ≥ 5% and ≤ 20% the value for exposure mortality E should be corrected by using the following formula below [11].

$$\text{Corrected exposure mortality (\%)} = \left(\frac{E-C}{100-C}\right) \times 100 \qquad (3)$$

where, E is the Exposure mortality and C, control mortality.

## 3.0 RESULTS AND DISCUSSION

**Table 1:** Percentage mortality of mosquitoes for Dichloro-diphenyl-trichloro-ethane (DDT)

| Study sites | (N) | % Mortality | Status |
|---|---|---|---|
| Kekkel | 25(100) | 62% | R |
| Bare | 25(100) | 43% | R |
| Poshiya | 25(100) | 14% | R |
| Komta | 25(100) | 15% | R |
| Kasuwa | 25(100) | 10% | R |

S = susceptible; R = resistance; N = number of mosquitoes exposed

**Table 2:** Percentage mortality of mosquitoes for Deltamethrin

| Study sites | (N) | % Mortality | Status |
|---|---|---|---|
| Kekkel | 25(100) | 100% | S |
| Bare | 25(100) | 100% | S |
| Poshiya | 25(100) | 100% | S |
| Komta | 25(100) | 100% | S |
| Kasuwa | 25(100) | 100% | S |

S = susceptible; R = resistance; N = number of mosquitoes exposed

### 3.1 Mortality

The results of this investigation provide evidence of DDT resistance in mosquitoes from all the five communities. Deltamethrin resistance was not detected in all the five sites. According to WHO recommendations, 98-100% mosquito mortality after 24 hours post exposure period indicates susceptibility, 80-97% suggests potential resistance that needs to be confirmed, and < 80% mortality suggest resistance. Mosquitoes from the five communities were fully (100%) susceptible to deltamethrin on the 24 hours post exposure period as shown in (Table **1**). No signs of resistance observed. Contrarily, results in Table **2**show thatmosquitoes exposed to DDT after 24 hours gave lover mortality rate with Kekkel having 62%, Bare 43%, Poshiya 14%, Komta 15% and Kasuwa 10%. The higher disparity in knockdown and mortality observed in deltamethrin exposure compared to DDT indicated a high level of efficacy.

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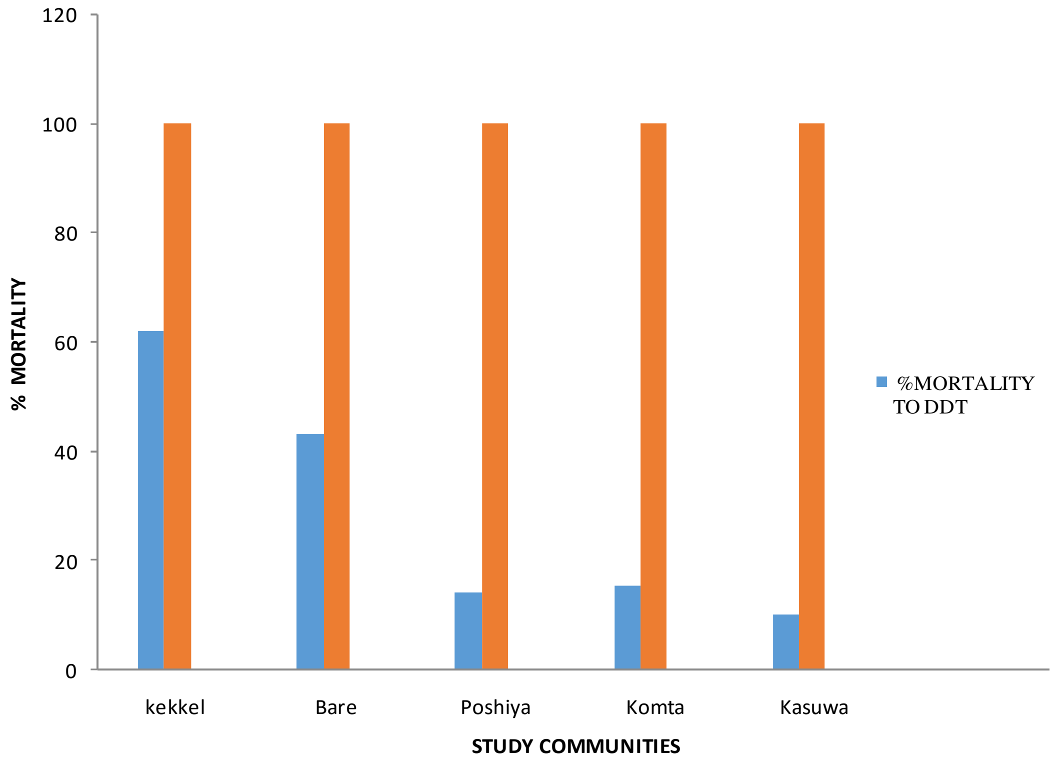


**Figure 1:** Insecticide susceptibility test for DDT and deltamethrin from the five communities

The presence of DDT resistance at is not surprising given the numerous reports of insecticide resistance in other West African countries (Bouwman et al 2006). Other factors that may result to mortality of mosquitoes is stress when transferring mosquitoes from the impregnated test tubes after 1hour to the post exposure tube for 24hours. Similar instances were observed in the work of [12] which reported other factors responsible for susceptibility of mosquitoes to different classes of insecticides.

Mortality rate of mosquitoes to DDT does agree with the World Health Organization recommendations that 98-100% mosquito mortality indicates susceptibility, 80-97% suggest potential resistance that needs to be confirmed and < 80% suggest resistance. Poshiya, Komta and Kasuwa showed very low percentage mortality with less than 20% though; this communities are more developed than Bare and Kekkel. However, many other factors also stimulate the occurrence of insecticide tolerance. For example, frequent use of insecticides with the same mode of action can accelerate the development of resistance. This is in consistence with the findings [13] which reported resistance of mosquito species in urban settlements exposed from Sudan and Kenya.The findings of this study indicated that all the five communities of Billiri, mosquito population is susceptible to deltamethrin, as >98% mortality was recorded after 24hours post exposure period indicating full susceptibility. This findings contradicts that of [14] who reported pyrethroid insecticide resistance in mosquito species population from the South-Eastern part of Nigeria, but is consistence with work of [15] which reported insecticide susceptibility of malaria vector, *Anopheles gambiae* in North-Central Nigeria.

Ideally, before any insecticide-based control activities are introduced, the levels of insecticide resistance in the main malaria vector should be assessed to provide information for measuring the effectiveness of the intervention. However, in most West African and sub-Saharan African countries, insecticide resistance monitoring is given a low priority by the National Malaria Control Programs [16]. With the take-off of the Gombe State Indoor Residual Spraying (IRS) programmed, it is important that a resistance management strategy is put in place that includes routine monitoring of insecticide resistance and investigation of alternative insecticides for IRS. The present study sites provide ideal focal points for malaria surveillance as insecticide resistance data can be directly linked to both epidemiological and clinical data.

## 4.0 CONCLUSION

Mosquitoes in the five communities covered in this study are susceptible to deltamethrin and therefore the use of deltamethrin insecticide is still an effective means of blocking malaria transmission in the region, and possibly other nearby communities. In view of the rapidity of the development of resistance, it is suggested that newer and efficacious insecticides are developed to guaranty continued effective control of the mosquito vector in case resistance to deltamethrin develops in the near future.

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